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# REINVENTING CONSTRUCTION: A ROUTE TO HIGHER PRODUCTIVITY

FEBRUARY 2017

IN COLLABORATION WITH
MCKINSEY'S CAPITAL PROJECTS & INFRASTRUCTURE PRACTICE

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# REINVENTING CONSTRUCTION: A ROUTE TO HIGHER PRODUCTIVITY

FEBRUARY 2017

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IN BRIEF

# REINVENTING CONSTRUCTION

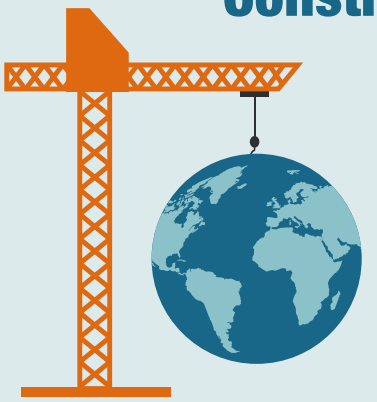
The construction sector is one of the largest in the world economy, with about $10 trillion spent on construction-related goods and services every year. However, the industry's productivity has trailed that of other sectors for decades, and there is a $1.6 trillion opportunity to close the gap.

- Globally, construction sector labor-productivity growth averaged 1 percent a year over the past two decades, compared with 2.8 percent for the total world economy and 3.6 percent for manufacturing. In a sample of countries analyzed, less than 25 percent of construction firms matched the productivity growth achieved in the overall economies where they work over the past decade. Absent change, global need for infrastructure and housing will be hard to meet. If construction productivity were to catch up with the total economy, the industry's value added could rise by $1.6 trillion a year. That would meet about half of the world's annual infrastructure needs or boost global GDP by 2 percent. One-third of the opportunity is in the United States, where, since 1945, productivity in manufacturing, retail, and agriculture has grown by as much as 1,500 percent, but productivity in construction has barely increased at all.
- The new MGI Construction Productivity Survey confirms many reasons for this poor performance. The industry is extensively regulated, very dependent on public-sector demand, and highly cyclical. Informality and sometimes corruption distort the market. Construction is highly fragmented. Contracts have mismatches in risk allocations and rewards, and often inexperienced owners and buyers find it hard to navigate an opaque marketplace. The result is poor project management and execution, insufficient skills, inadequate design processes, and underinvestment in skills development, R&D, and innovation.
- The productivity performance of global construction is not uniform. There are large regional differences, and major variations within the industry. The sector splits broadly in two: large-scale players engaged in heavy construction such as civil and industrial work and large-scale housing, and a large number of firms engaged in fragmented specialized trades such as mechanical, electrical, and plumbing work that act as subcontractors or work on smaller projects like refurbishing single-family housing. The first group tends to have 20 to 40 percent higher productivity than the second. However, even in the more productive heavy construction sector there are endemic—potentially structural—challenges in meeting cost and schedule commitments on megaprojects, and players routinely subcontract specialized trades.
- Examples of innovative firms and regions suggest that acting in seven areas simultaneously could boost productivity by 50 to 60 percent. They are: reshape regulation; rewire the contractual framework to reshape industry dynamics; rethink design and engineering processes; improve procurement and supply-chain management; improve on-site execution; infuse digital technology, new materials, and advanced automation; and reskill the workforce. Parts of the industry could move toward a manufacturing-inspired mass-production system that would boost productivity up to tenfold. Industrial and infrastructure megaprojects need to instill holistic project-operating systems on-site and in design offices. The highly non-linear and challenging nature of megaprojects underscores the difficulty of, and necessity for, moving toward an industrialized project-operating system.
- Many barriers to higher productivity and ways of overcoming them have been known for some time, but the industry has been in deadlock. Most individual players lack both the incentives and the scale to change the system. However, there are forces lowering the barriers for change: rising requirements and demand in terms of volume, cost, and quality; larger-scale players and more transparent markets, and disruptive new entrants; more readily available new technologies, materials, and processes; and the increasing cost of labor with partial restrictions on migrant workers. Construction-sector participants should rethink their operating approaches to avoid being caught out in what could be the world's next great productivity story.

# The productivity opportunity in construction

## Construction matters for the world economy

### ... but has a long record of poor productivity



**Construction-related spending** accounts for

**13%** of the world's GDP

...but the sector's annual productivity growth has only increased

**1%** over the past **20 years**

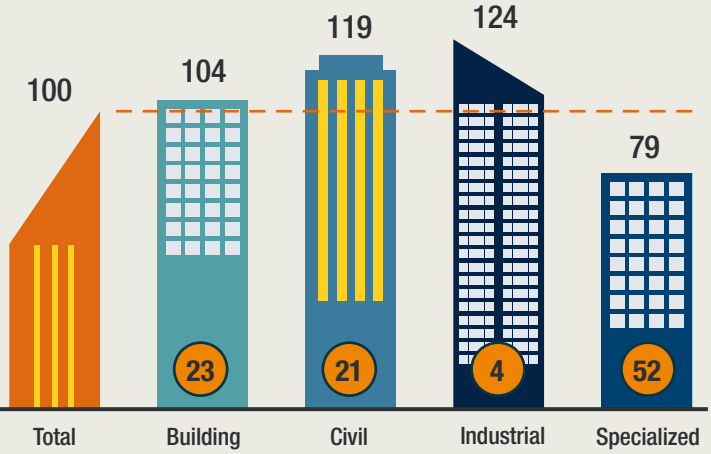
**$1.6 trillion** **of additional value added** could be created through higher productivity, meeting **half the world's infrastructure need**

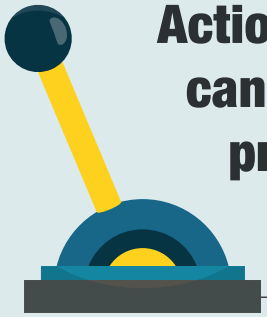
## Construction is a sector of two halves

Fragmented specialized trades drag down the productivity of the sector as a whole

**Construction productivity by subsector**
Value added per employee, indexed total sector=100, 2013

**% of construction value added**



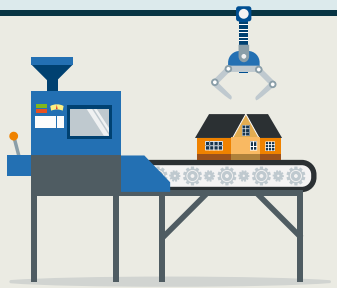



## Action in seven areas can boost sector productivity by 50–60%

- Reshape regulation
- Rewire contracts
- Rethink design
- Improve procurement and supply chain
- Improve onsite execution
- Infuse technology and innovation
- Reskill workers

## 5–10x productivity boost

possible for some parts of the industry by moving to a manufacturing-style production system



One person with construction helmet looks of a 100-story skyscraper on a 88-story skyscraper in the center of Shanghai
© Steffen Schnur /Getty Images

# EXECUTIVE SUMMARY

Every year, there is about $10 trillion in construction-related spending globally, equivalent to 13 percent of GDP. This makes construction one of the largest sectors of the world economy. The sector employs 7 percent of the world's working population and, by building the structures in which we live and work, which create our energy, materials, and goods, and on which we travel, has an impact well beyond its own boundaries. Construction matters.

However, construction has suffered for decades from remarkably poor productivity relative to other sectors.[1] Other sectors have transformed themselves, boosting productivity. In retail, the mom-and-pop stores of half a century ago have been replaced by large-scale modern retailers such as Aldi and Walmart, with global supply chains and increasingly digitized distribution systems and customer-intelligence gathering. In manufacturing, lean principles and aggressive automation have been transformative. In comparison, much of construction has evolved at a glacial pace.

It is not easy to make assumptions about how productive a sector should be in comparison with others, but global labor-productivity growth in construction has averaged only 1 percent a year over the past two decades (and was flat in most advanced economies). Contrasted with growth of 2.8 percent in the world economy and 3.6 percent in manufacturing, this clearly indicates that the construction sector is underperforming. The United States highlights the industry's challenge. While many US sectors including agriculture and manufacturing have increased productivity ten to 15 times since the 1950s, the productivity of construction remains stuck at the same level as 80 years ago. Current measurements find that there has been a consistent decline in the industry's productivity since the late 1960s.[2]

If construction labor productivity were to catch up with the progress made by other sectors over the past 20 years or with the total economy (and we show that it can), we estimate that this could increase the construction industry's value added by $1.6 trillion a year. This is equivalent to the GDP of Canada, or meeting half of global infrastructure needs, or boosting global GDP by 2 percent a year.

Yet despite the substantial benefits that would come from raising the sector's productivity, and despite the fact that the challenges are well known and have long been discussed in the industry, progress has been limited. The industry operates in a way that seems to evolve only very slowly at best, and it is beset with misaligned incentives among owners and contractors and with market failures such as fragmentation and opacity. There is a question around how much the move from "patient capital" toward "quarterly earnings" has affected the industry's ability to invest in itself. Some governments have now begun to address the poor productivity of construction head-on and are attempting to break the deadlock in which the industry appears to find itself. The industry needs a more productive approach—

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1 The McKinsey Global Institute has studied productivity in more than 20 countries and 30 industries, including construction. All reports are available in the productivity, competitiveness, and growth section of **www.mckinsey.com/mgi**.

2 Revisions to labor-productivity metrics in the United States are ongoing; see Leo Sveikauskas et al., "Productivity growth in construction," *Journal of Construction Engineering and Management*, volume 142, issue 10, October 2016. Early indications suggest that changes to measured prices will lead to an increase in measured labor-productivity growth particularly in subsectors such as highways, industrial construction, and homebuilding. This is consistent with patterns we observe in the divergence in productivity development, and level between heavy construction work and specialized trades (subcontracting) and repairs (see Chapter 2). For a discussion of measurement issues relating to construction, see the technical appendix.

demand for construction is rising. And the tools for that more productive approach are increasingly available through digital technologies and new materials.

In this report, we first look at the sector's poor historical record on productivity and performance, homing in on ten root causes. We then look in some detail at seven ways that, in combination, could improve the productivity of the sector by 50 to 60 percent and estimate the value that could be created with concerted action. We discuss the potential for larger parts of the industry to shift toward a higher-productivity production system in which the bulk of a construction project is built from prefabricated standardized components off-site in a manufacturing facility. In the case of industrial and infrastructure megaprojects, we see the need to move away from a primarily process-driven project system to a more holistic project-operating system in order to improve the industry's poor current performance on cost, schedule, and predictability. Recognizing and managing variance (plan conformance), flow, and inventory becomes critical. Finally, we explore which parts of the industry may be ripe for disruption and what measures each player might take to make change happen.

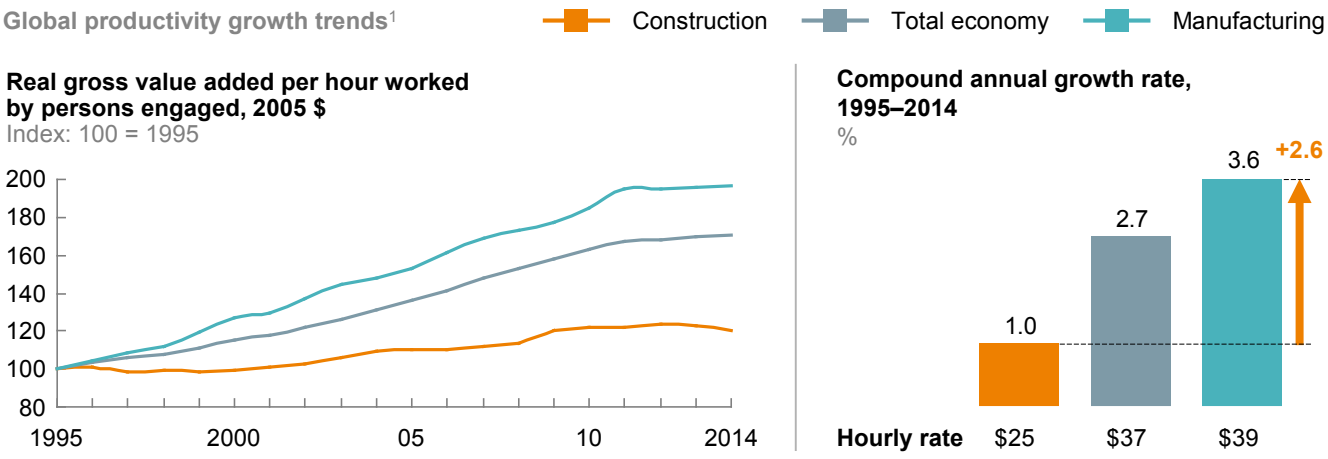
## CONSTRUCTION HAS AN INTRACTABLE PRODUCTIVITY PROBLEM

Today, around $10 trillion a year is being spent on the buildings, infrastructure, and industrial installations that are the backbone of the global economy, and demand is rising. By 2025, that amount is projected to total $14 trillion. However, the industry could produce more for this investment if productivity were higher, leading to a fundamental improvement in the world's infrastructure and the quality of life of citizens.

Globally, labor-productivity growth in construction has averaged only 1 percent a year over the past two decades, compared with growth of 2.8 percent for the total world economy and 3.6 percent in the case of manufacturing (Exhibit E1).[3] In a sample of countries analyzed, over the past ten years less than one-quarter of construction firms have matched the productivity growth achieved in the overall economies in which they work, and there is a long tail of usually smaller players with very poor productivity. Many construction projects suffer from overruns in cost and time.

Exhibit E1

**Globally, labor-productivity growth lags behind that of manufacturing and the total economy**




1 Based on a sample of 41 countries that generate 96% of global GDP.

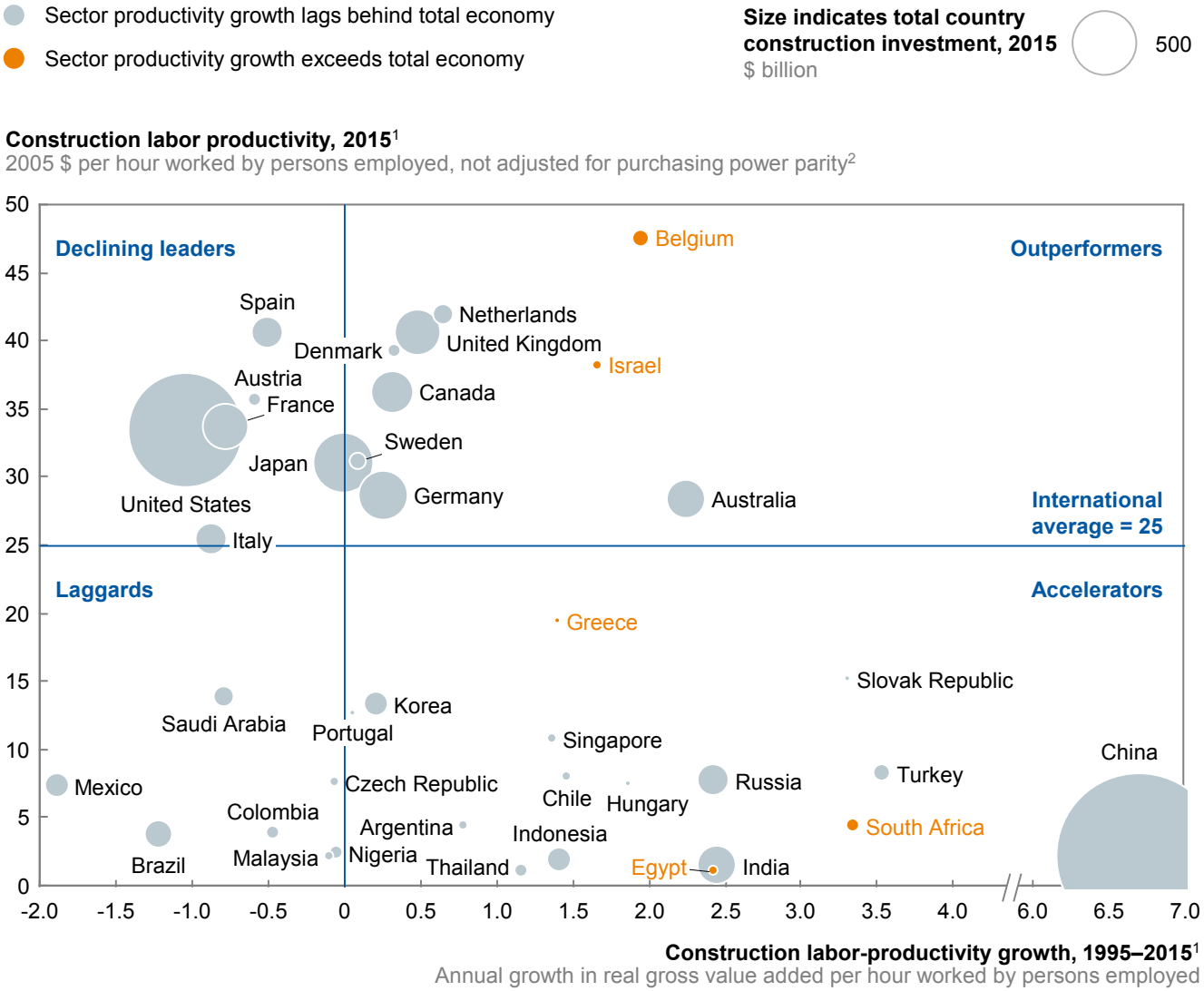
SOURCE: OECD; WIOD; GGCD-10, World Bank; BEA; BLS; national statistical agencies of Turkey, Malaysia, and Singapore; Rosstat; McKinsey Global Institute analysis

[3] Measuring productivity is challenging. We have used gross value added as our measure and used sector deflators to account for price fluctuations. For further detail, see the technical appendix. Our analysis refers to 41 countries that generate 96 percent of global GDP.

The labor-productivity performance of construction sectors around the world is not uniform. There are large regional differences as well as visible pockets of excellence. In the United States, for instance, the sector's labor productivity is lower today than it was in 1968[4]. Indeed, the US construction sector accounts for one-third of the opportunity to boost global productivity identified in this research. Europe's productivity is largely treading water. China and South Africa are increasing their productivity rapidly, albeit from a low base, while countries such as Brazil and Saudi Arabia are falling further behind. A few smaller countries—notably Australia, Belgium, and Israel—are managing to combine high measured productivity levels with comparatively fast growth (Exhibit E2).

Exhibit E2

**A small number of countries have achieved healthy productivity levels and growth rates**




1 Countries with a shorter time series due to data availability: Argentina, Australia, Brazil, Chile, Ethiopia, Japan, Mexico, Nigeria, South Africa (1995–2011); Belgium (1999–2014); China, Colombia (1995–2010); Czech Republic, France, Israel, Malaysia, Russia (1995–2014); Egypt (1995–2012); Indonesia (2000–14); Saudi Arabia (1999–2015); Singapore (2001–14); Thailand (2001–15); and Turkey (2005–15).
2 Published PPPs are either not applicable (i.e., are not for the construction sector specifically or not for a value-added metric) or vary too widely in their conclusions to lend any additional confidence to the analysis.

SOURCE: OECD Stat; EU KLEMS; Asia KLEMS; World KLEMS; CDSI, Saudi Arabia; Ministry of Labor, Saudi Arabia; WIOD; GGDC-10; Oanda; IHS; ITF; GWI; McKinsey Global Institute analysis

4 Leo Sveikauskas et al., "Productivity growth in construction," *Journal of Construction Engineering and Management*, volume 142, issue 10, October 2016.

The low labor productivity of the construction industry is an important issue (see Box E1, "Why labor productivity in construction matters"). If construction sector productivity were to catch up with that of the total economy—and we will show that it can—this would boost the sector's value added by an estimated $1.6 trillion, adding about 2 percent to the global economy a year. This would correspond to an increase in construction value added using the same resources of almost 50 percent.

## A TALE OF TWO INDUSTRIES: CONSTRUCTION HAS TWO DISTINCT PARTS, EACH OF WHICH IS AFFECTED DIFFERENTLY BY A RANGE OF MARKET FAILURES

The construction sector is not homogeneous. It splits more or less in half between large-scale players engaged in heavy construction such as civil and industrial work and large-scale housing, and a large number of fragmented specialized trades such as mechanical, electrical, and plumbing that act as subcontractors or work on small projects such as single-family housing or, increasingly, particularly in Europe and the United States, refurbishment and repair work. The first group tends to have much higher productivity than the second.

In the first group, contractors involved in industrial infrastructure have, on average, the highest productivity at 124 percent of the figure for the industry as a whole, followed by civil construction players at 119 percent and large-scale building contractors at 104 percent.[5] Trades subcontractors, which are responsible for a large share of value in small real estate and refurbishment projects, are typically relatively small; their productivity is about 20 percent lower than the sector average. The higher-productivity large-scale half of the industry is not immune to the low productivity of the other half. Large-scale players routinely subcontract to smaller specialized players, and, in the United States, the productivity in civil, industrial, and buildings including trades subcontractors drops by 12, 26, and 28 percent, respectively. Therefore, any action to boost sector productivity needs to apply to the entire supply chain and to both parts of the market—each of which lags behind manufacturing in its productivity (Exhibit E3).

[5] We calculated construction sector productivity using productivity data for 18 countries: Australia, Canada, the European Union (EU) 15, and the United States. We calculated the average productivity of construction in each country, then indexed that to the total economy level. See the technical appendix for more detail on our methodology.

### Box E1. Why labor productivity in construction matters

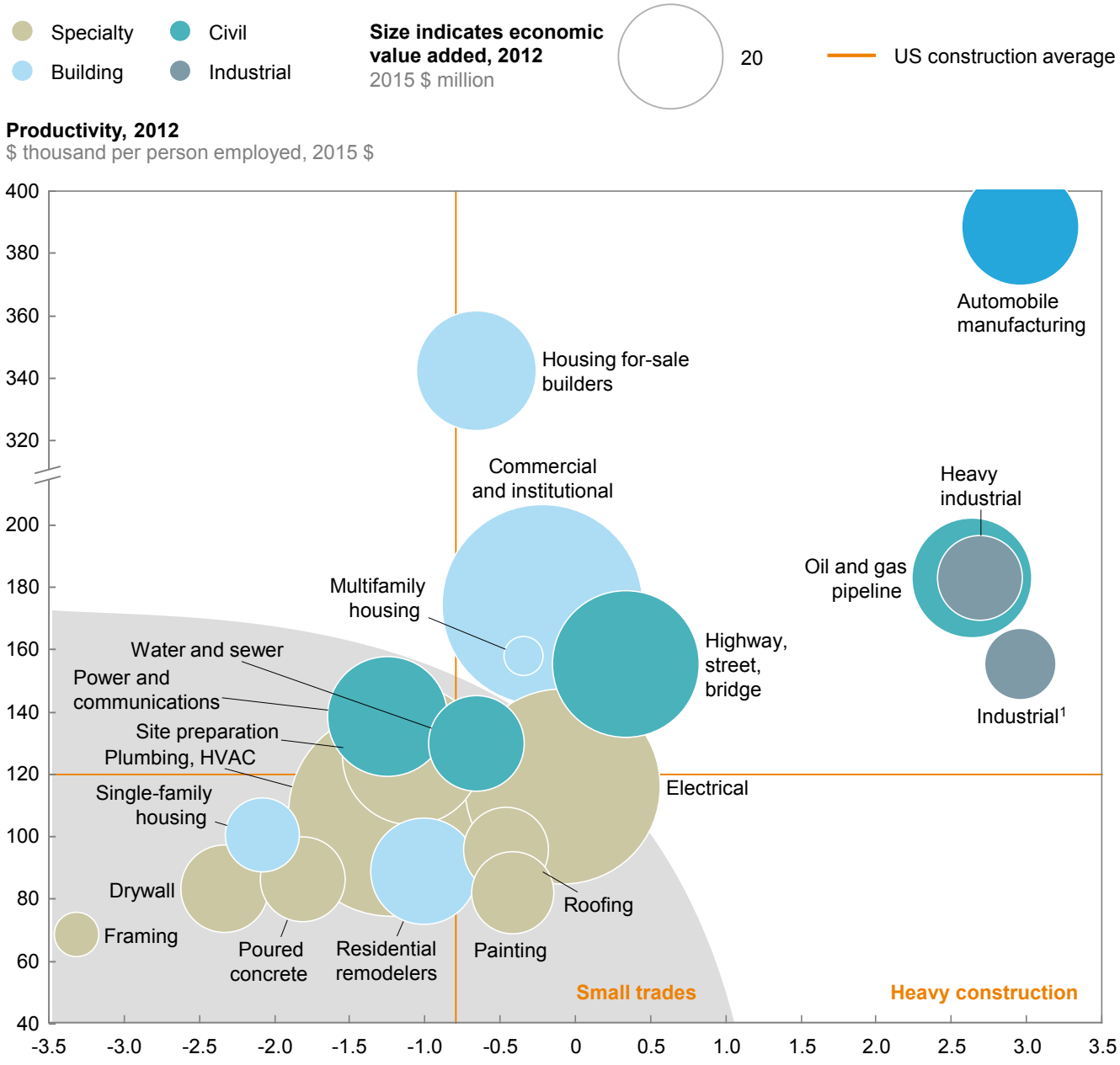
We focus this report on labor productivity, defined as the value added by construction workers (output in terms of structures created minus purchased materials) per hour of work and its growth over time, adjusted for inflation. An increase means that higher value can be provided to customers with the same or fewer resources, which translates into a desirable mix of higher-quality structures at lower cost for owners, higher profitability for contractors, and higher wages for workers. Any one or two of these objectives can also be achieved without productivity growth—for instance, squeezing wages or margins to lower costs or raising prices for owners to be able to meet wage requirements—but the combination of all three requires productivity growth. High labor productivity often also goes hand in hand with shorter and more reliable schedules.

Exhibit E3

**Smaller trades trail on productivity levels and growth**

NOT EXHAUSTIVE

US example




1 Manufacturing plants and warehouses.
2 All subsectors deflated with overall construction sector deflators, not subsector-specific prices.

SOURCE: US Economic Census; McKinsey Global Institute analysis

We identified ten causes of low productivity and market failures in the construction industry (Exhibit E4).

At the macro level, projects and sites are becoming increasingly complex and brownfield-, refurbishment-, or repairs-oriented, and are challenged by geographic dispersion and fragmented land markets. In addition, the construction industry faces extensive regulation and dependency on public-sector demand. Informality, and sometimes outright corruption, distorts the market. Compounding these issues are industry dynamics that contribute to

low productivity—construction is among the most fragmented industries in the world, the contracting structures governing projects are rife with mismatched risk allocation, and owners and buyers, who are often inexperienced, must navigate a challenging and opaque marketplace. The results are operational failures within firms, including inefficient design with limited standardization; insufficient time spent on planning and implementing the latest thinking on project management and execution; and a low-skilled workforce. In addition, the construction industry is highly volatile and has bottom-quartile profit margins compared with other sectors, constraining investment in the technology and digitization that would help raise productivity.

Exhibit E4

**We tested ten root causes for low construction productivity**

| | External forces | Industry dynamics | Firm-level operational factors |
|---|---|---|---|
| **Root causes** | ▪ Increasing project and site complexities<br>▪ Extensive regulation, land fragmentation, and the cyclical nature of public investment<br>▪ Informality and potential for corruption distort the market | ▪ Construction is opaque and highly fragmented<br>▪ Contractual structures and incentives are misaligned<br>▪ Bespoke or suboptimal owner requirements | ▪ Design processes and investment are inadequate<br>▪ Poor project management and execution basics<br>▪ Insufficiently skilled labor at frontline and supervisory levels<br>▪ Industry underinvests in digitization, innovation, and capital |

SOURCE: McKinsey Global Institute analysis

The most important market failures and dynamics vary between the two groups. For heavy contractors, suboptimal procurement criteria by public and private owners (focused on reducing initially offered prices and offloading risk) combined with, in some cases, corruption or inexperience among buyers—particularly in the public and residential sectors—have nurtured an environment of misaligned contractual and incentive structures. This has led to hostility and change orders rather than productive and trusted collaboration. The results of a new MGI Construction Productivity Survey confirm this picture of lack of alignment across the industry.[6] For example, contractors and suppliers identified misaligned contracts as the most important root cause of low productivity, while the top root cause cited by owners was inefficient on-site execution.

Key issues for smaller specialized trade contractors and subcontractors include information asymmetries that reflect the fragmentation of this part of the construction sector, and the geographic dispersion of projects that compromise the cost transparency of projects for owners and make it more difficult for contractors to benefit from scale. Furthermore, small

[6] Our discussion of the heavy construction part of the industry was informed by a survey administered to 5,000 construction-industry CEOs representing asset owners, engineering and construction firms, suppliers, other institutions such as construction consulting firms, academics, and industry associations such as the Construction Industry Institute. Participants were asked to rank the relative importance of root causes of low productivity and to indicate what their companies were doing to address them. Responses were received from companies active in all regions of the world. See the technical appendix for more detail. For specialized trades, we drew on McKinsey's work in the field as well as a considerable body of MGI research, including country case studies on residential construction. All are available at **www.mckinsey.com/mgi**.

and specialized trade contractors offering higher-productivity solutions are held back by competition from contractors using less productive but cheaper informal labor and by regulation such as heterogeneous zoning and building codes. Many players in the industry benefit from today's market failures, earning a substantial share of revenue and profits from change orders and claims, and reducing exposure to competition in an opaque market.

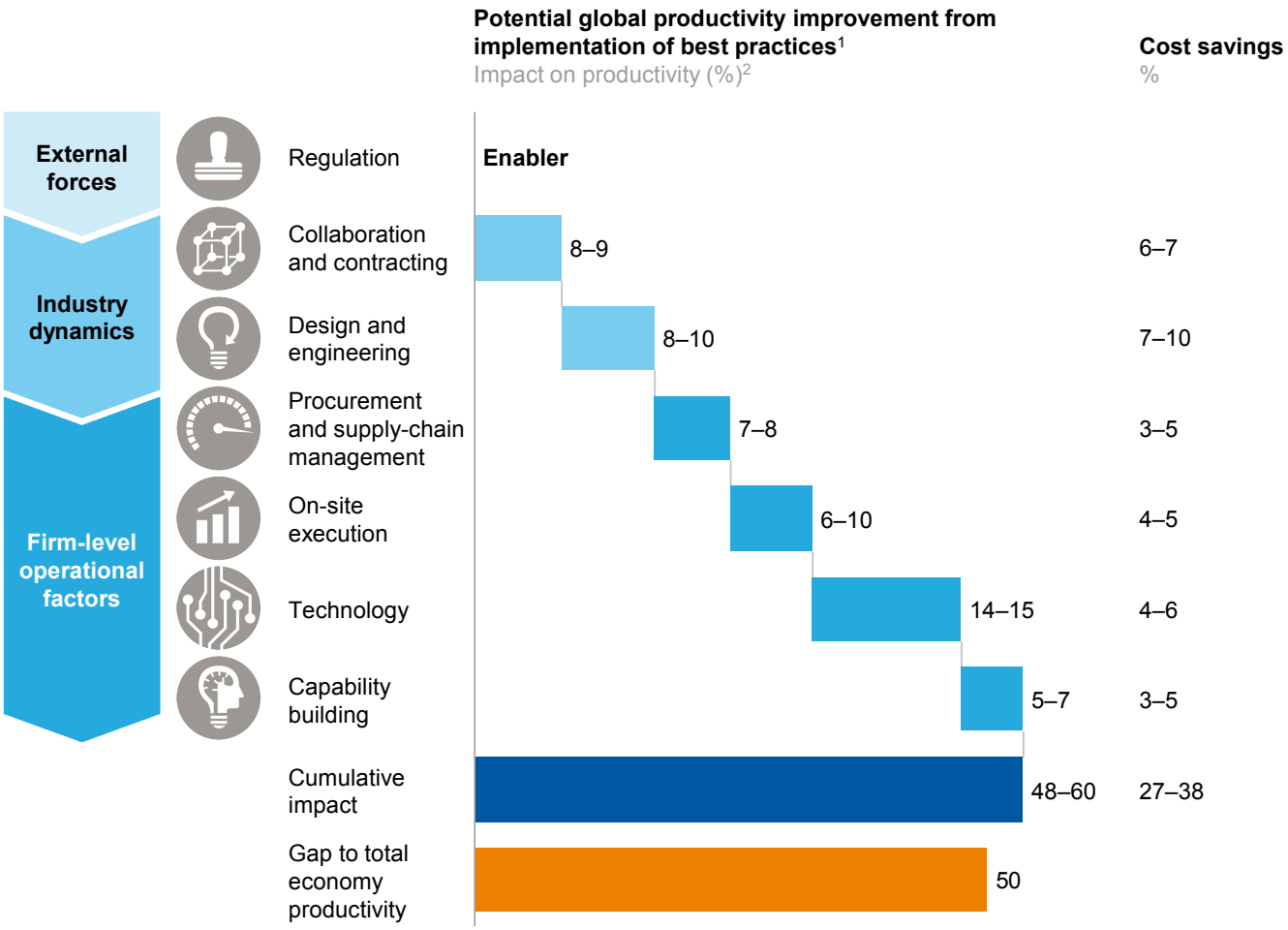
## THERE ARE SEVEN WAYS TO TACKLE THE TEN ROOT CAUSES THAT UNDERLIE CONSTRUCTION'S POOR PRODUCTIVITY

It doesn't have to be this way. We have identified seven ways innovative companies and regions are addressing current market failures and improving productivity—as well as cost and schedule reliability—in the construction industry. With action and widespread adoption of all seven, the sector's productivity could be 50 to 60 percent higher (Exhibit E5).

Exhibit E5

**Construction can catch up with total economy productivity by taking action in seven areas**

**Cascading effect**
Regulation changes facilitate shifts in industry dynamics that enable firm-level levers and impact




1 The impact numbers have been scaled down from a best case project number to reflect current levels of adoption and applicability across projects, based on respondents to the MGI Construction Productivity Survey who responded "agree" or "strongly agree" to the questions around implementation of the solutions.
2 Range reflects expected difference in impact between emerging and developed markets.

SOURCE: McKinsey Global Institute analysis

Many of the aspects of these seven levers for higher productivity are not surprising, but the industry has not universally applied basic approaches and, even when it has, there is an opportunity to push for best practices:

- **Reshape regulation and raise transparency.** Actions include streamlining permitting and approvals processes, as Australia has done; reducing informality and corruption; and encouraging transparency on cost and performance, as the International Construction Measurement Standards project does.[7] Many governments allocate grants for innovation and training. Germany's Federal Ministry of Transport and Digital Infrastructure (formerly the Federal Ministry of Transport, Building, and Urban Development), for instance, supports R&D through studies in building materials. Best-practice regulation would include moving toward outcome-based, more standardized building codes, and consolidating land to promote scale. Examples include Singapore's move to allow cross-laminated timber (CLT) for high-rise structures and Japan's promotion of scale through land pooling.

- **Rewire the contractual framework.** There is a need to move away from the hostile contracting environment that characterizes many construction projects to a system focused on collaboration and problem solving. To achieve this, tendering processes can be based on best value and past performance rather than cost alone, and public processes streamlined. Establishing a "single source of truth" on projects for monitoring progress early, potentially supported by collaborative technology, helps to minimize misalignments and enable joint corrective action. The data already exist to fundamentally improve the accuracy of cost and schedule estimates. Where players continue to use traditional contracts, they should introduce incentives that significantly improve performance and alignment not at a trade or package level, but at the project-outcome level. To move toward best practices, appropriate alternative contracting models such as integrated project delivery (IPD) help build long-term collaborative relationships. Relational contracts will need to become more prevalent than transactional contracts. Sufficient investments in up-front planning incorporating all parties' input have been shown to raise productivity substantially.

- **Rethink design and engineering processes.** Institutionalizing value engineering into the design process with a greater focus on constructability, and pushing for repeatable design elements in those projects that do not require bespoke solutions would make a contribution to boosting productivity. The biggest impact on productivity would come from moving toward thinking about construction as a production system, where possible encouraging off-site manufacture, minimizing on-site construction through the extensive use of pre-cast technology, assembling panels in factories and then finishing units on-site. To indicate the scale of the opportunity, only 50 percent of respondents to the MGI Construction Productivity Survey said that their firms had a standard design library.[8] In asset classes for which standardization might not be the panacea, the opportunity for parameter specification rather than individual company specifications is significant. Our analysis of sectors such as deepwater oil and gas underscores what a highly significant and largely uncaptured opportunity this is. The automobile and aerospace industries provide insight into how tighter integration with contractors might evolve.

- **Improve procurement and supply-chain management.** A combination of best practices seen in other industries and innovative, digitally enabled approaches can deliver substantial change. Improved planning and increased transparency among contractors and suppliers would reduce delays significantly. Properly skilled central procurement teams can drive economies of scale for certain products across those

[7] This is a coalition established to develop transparency on costs internationally and the ability to benchmark between them.

[8] MGI surveyed 5,000 construction-industry CEOs representing asset owners, engineering and construction firms, suppliers, and other institutions such as construction consulting firms, academics, and industry associations. Participants were asked to rank the relative importance of root causes of low productivity, and indicate what their companies were doing to address them. Responses were received from companies active in all regions of the world.

sites. Best practice in areas such as digitizing procurement and supply-chain workflows will enable more sophisticated logistics management and just-in-time delivery. Katerra, for instance, recently launched a data-enhanced global sourcing model to help develop a supply chain that reacts to potential disruptions and market dynamics with predictive replenishment of supplies informed by inventories connected to the Internet of Things (such as wearable devices, radio frequency ID tags, and sensor technology). The construction sector ranks in the lower range of sophistication in the Global Purchasing Excellence Survey published by McKinsey's Procurement Practice, suggesting ample room for improvement.

- **Improve on-site execution.** There are four key approaches that are well known in the industry but have not been universally adopted. First is the introduction of a rigorous planning process—the Last Planner® System (LPS) is a useful tool—to ensure that key activities are achieved on time and on budget.[9] The use of integrated planning tools on a large-scale oil and gas project, for instance, achieved a 70 percent increase in the project's productivity. Second is reshaping the relationship and interactions between owners and contractors, and key performance indicators (KPIs) being agreed on and used at regular performance meetings at which on-site issues are resolved. Complementing commonly used KPIs with additional forward-looking plan conformance metrics to identify, and subsequently reduce, variance is critical. Third is improving the mobilization for new projects by ensuring that all pre-work (for instance, obtaining approvals and developing project milestones) has been completed prior to starting on-site. Finally, there is a need for careful planning and coordination of different disciplines on-site along with the application of lean principles to reduce waste and variability. At the heart of this issue is a need to move from systems that rely primarily on process and command-and-control toward a more holistic operating system. The sheer complexity and variability of today's megaprojects require a project-operating approach that integrates technical and management systems and fully harnesses workers' capabilities. In the future, new forms of digital collaboration, notably the Internet of Things and advanced analysis, will combine to enable tracking of equipment and materials and therefore greater transparency.

- **Infuse digital technology, new materials, and advanced automation.** Companies can start by making 3D building information modeling (BIM) universal within the company alongside use of digital collaboration tools, drones, and unmanned aerial vehicles for scanning, monitoring, and mapping. They can put themselves at the cutting edge by using platforms such as 5D BIM to establish transparency in design, costing, and progress visualization; advanced analytics enabled by the Internet of Things to improve on-site monitoring of materials, labor, and equipment productivity; and digital collaboration and mobility tools (such as construction management apps loaded on mobile devices) to better track progress and collaborate in real time. On-site productivity can be increased by as much as 50 percent by implementing a cloud-based control tower that rapidly assembles accurate data in near real time that is both backward-looking and predictive (for example, using plan conformance and other variability and inventory metrics). Importantly, owners need to ensure that the right data flow through the various owner, contractor, and subcontractor systems. Big data also has a significant role to play. Techniques and data that are readily available today can produce large improvements in the accuracy of cost and schedule estimates as well as engineering productivity. Developing new lightweight materials and construction methodologies such as prefabricated pre-finished volumetric construction can further facilitate off-site fabrication. Advanced automated equipment and tools such as bricklaying and tiling robots can accelerate on-site execution. The introduction of predictive analytics and

[9] Registered to the Lean Construction Institute.

pattern recognition has enabled far more sophisticated monitoring of construction projects; one example is the network of sensors installed to track the impact of tunneling works for London's Crossrail project. MGI's productivity survey indicated that the biggest barriers to innovation by construction companies are underinvestment in IT and technology more broadly, and a lack of R&D processes. Establishing innovation officers can make a difference for technology adoption.

- **Reskill the workforce.** Change in the construction sector cannot be achieved without investment in retooling a workforce that is aging and changing its makeup through migration. Construction firms and workers need to continuously reskill and train to use the latest equipment and digital tools. In the mix should be apprenticeship programs such as the one run by Siemens in the United Kingdom, training frontline workers in core skills that are currently underdeveloped; and increasing stability in the workforce by breaking seasonality and cyclicality.

## THERE IS AN OPPORTUNITY FOR PARTS OF THE CONSTRUCTION INDUSTRY TO MOVE TO A PRODUCTION SYSTEM—AND BOOST PRODUCTIVITY UP TO TENFOLD

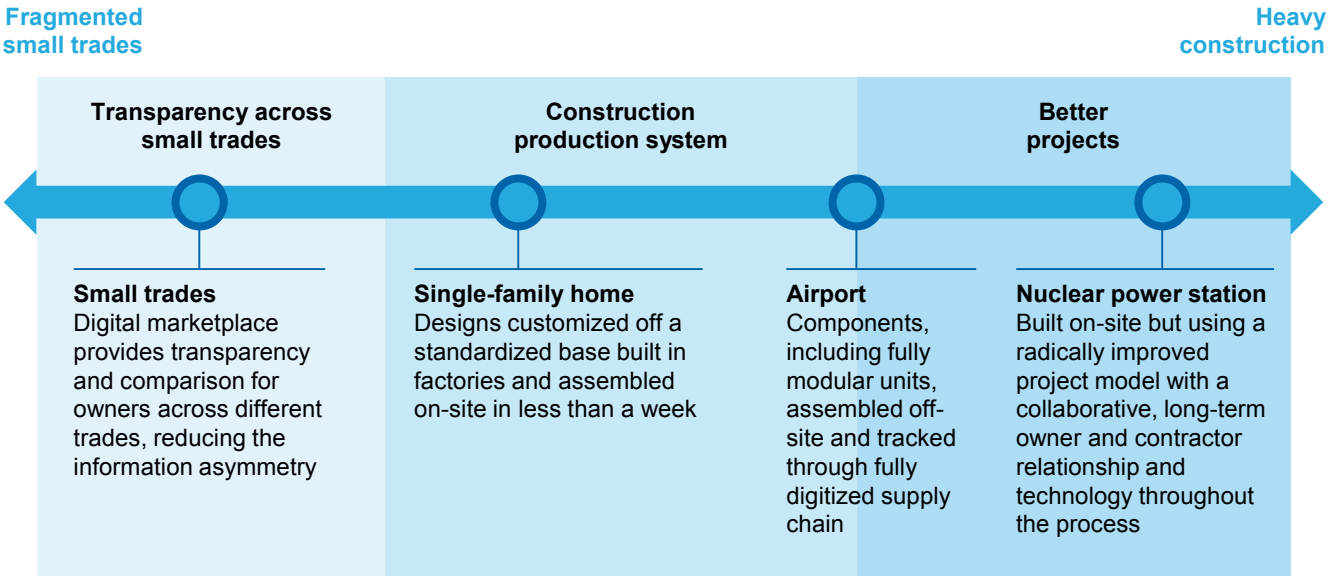
The seven areas that need to be addressed can boost productivity on projects by some 50 to 60 percent. However, if construction were to depart from entirely project-based approaches to more consistently employ a manufacturing-like system of mass production with much more standardization and manufacturing of modules and parts in factories off-site, the productivity boost could be an order of magnitude greater.

Examples of firms that are moving to a production system suggest that a productivity boost of five to ten times could be possible. For instance, Barcelona Housing Systems, which builds replicable four-story multifamily buildings, aims to have a full production system in place in 2018 that can build five to ten times more units than traditional construction with the same amount of labor. Finnish industrial company Outotec has stated that its mobile flotation plant for small mines requires 20 percent less capital investment and 30 percent less labor, and is 30 percent faster to install than alternatives. Broad Sustainable Buildings of China, which has erected a 30-story hotel in just 15 days, estimates that its buildings cost 10 to 30 percent less than structures erected in the traditional way. Dramatic time and cost savings reported—or aspired to—by these firms add up to much higher productivity. A broader shift to a production system would negate the majority of market failures that we identify in Chapter 2, simplifying and streamlining the construction ecosystem and making it more efficient.

The shift to a production system will not be possible for the entire sector. For some parts of the industry, the answer is a more effective and efficient project-based system, but many players could embrace a much more radical approach. Construction projects cover a broad spectrum in size and complexity, and change of different forms is possible along the breadth of that spectrum (Exhibit E6).

Exhibit E6

**Construction in the middle of the project-scale spectrum can be dramatically different in a production system**


Fragmented small trades
Heavy construction
Transparency across small trades
Construction production system
Better projects
Small trades
Digital marketplace provides transparency and comparison for owners across different trades, reducing the information asymmetry
Single-family home
Designs customized off a standardized base built in factories and assembled on-site in less than a week
Airport
Components, including fully modular units, assembled off-site and tracked through fully digitized supply chain
Nuclear power station
Built on-site but using a radically improved project model with a collaborative, long-term owner and contractor relationship and technology throughout the process

SOURCE: McKinsey Global Institute analysis

## WHERE AND HOW MIGHT DISRUPTION PLAY OUT IN THE CONSTRUCTION INDUSTRY?

Today the industry is in deadlock. Owners should be the main beneficiaries of a move to a more productive model but tend to be risk-averse and inexperienced; they need productive contractors that they can trust and that provide them with choice, high quality, and low prices—at scale—before they can change procurement practices and build capabilities for a new paradigm. Many contractors stand to lose revenue and margin from moving to productivity-based competition unless owners and the broader industry environment move, too. A shift to productivity-based competition is only likely to be attractive if contractors can build the scale (and repeatability) needed to drive cost efficiencies from productivity gains that outweigh revenue losses from lower price points and fewer customer claims, and provide payback on up-front and ongoing investments in technology or skill building.

Individual players face a critical strategic question—whether to continue with established business practices or push for change. Even if they opt for the latter, making change happen will require commitment from both owners and contractors.

But now four types of disruption—which have transformed the productivity of other sectors—could help to break the deadlock and usher in a new era of higher productivity:

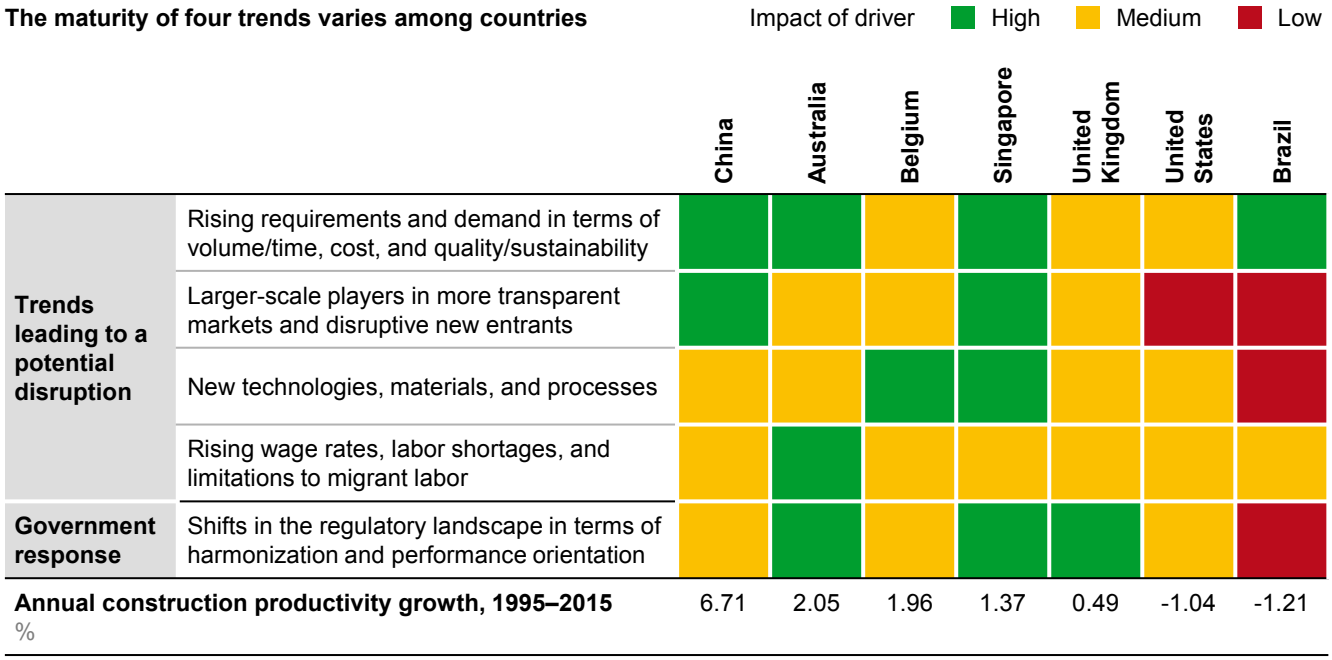
- Rising requirements and demand in terms of volume, time, cost, quality, and sustainability
- Larger-scale players, more transparent markets, and disruptive new entrants
- More readily available new technologies, materials, and processes
- Rising wage rates and limits on migrant labor

These trends could mean that the potential downside from not moving to a more productive model is more severe, and could increase the potential upside for those who move quickly. The maturity of trends has varied from country to country, with differential impact both on

historical productivity growth and on the potential for an ecosystem that will drive future improvements in productivity (Exhibit E7).

Exhibit E7

**The maturity of four trends varies among countries**




SOURCE: McKinsey Global Institute analysis

The four trends that we have discussed are likely to increase pressure on the industry to change. The potential for change will also be defined by the regulatory environment that supports it. To support productivity growth, regulators can mandate the use of BIM to build transparency and collaboration across the industry; reshape regulations to support productivity; create transparency on cost across the construction industry; publish performance data on contractors; and consider labor interventions to ensure the development of skills instead of relying heavily on a low-cost transient migrant workforce.

If industry players perceive their sector to be amenable to disruption, they need to take account of not only the trends creating that potential disruption but also the regulatory environment. Contractors can introduce a new operating system, invest in technology, and develop a strategic approach. Owners of every type can drive change (although those in the public sector tend to have the scale to drive the biggest impact). They can combine projects into portfolios of work and pipelines of projects to drive cost savings and build scale; and move away from bespoke design for each project.

•••

Change may not be a distant prospect—there are signs of potential disruption in parts of the global construction industry. The diagnostic is well known. Best practices already exist. The potential of a mass-production system offers the chance of a dramatic step change in productivity in some segments of the industry. But the question remains whether the various players in the sector, which have different incentives and challenges, will indeed leave behind the status quo and embrace change that will lead to higher productivity. Many are already doing so; many others will need to follow if the global construction sector is to end decades of inertia and transform itself as other industries have done.

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